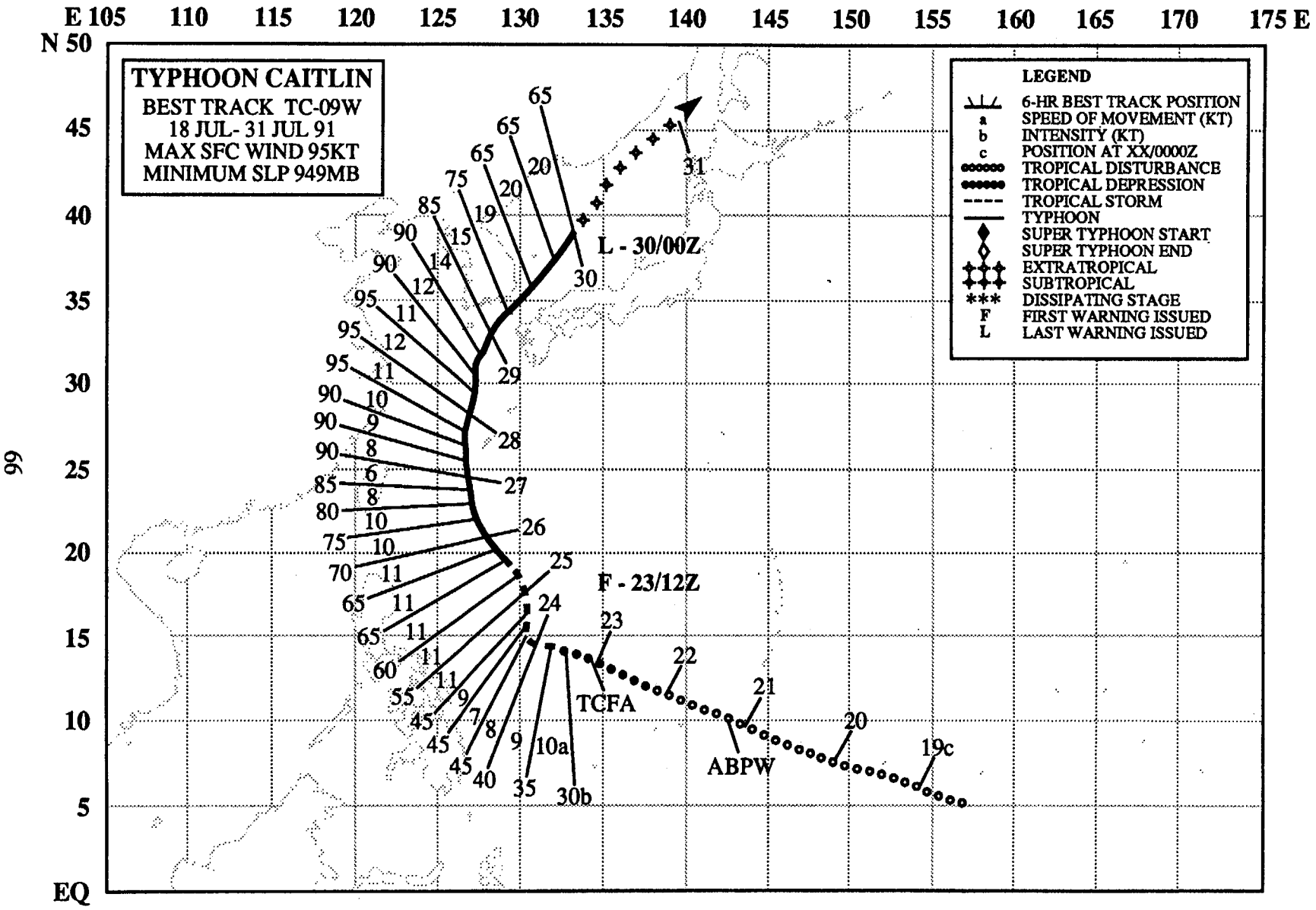
TYPHOON CAITLIN
BEST TRACK TC-09W
18 JUL- 31 JUL 91
MAX SFC WIND 95KT
MINIMUM SLP 949MB
LEGEND
6-HR BEST TRACK POSITION
a SPEED OF MOVEMENT (KT)
b INTENSITY (KT)
c POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
SUBTROPICAL
*** DISSIPATING STAGE
F FIRST WARNING ISSUED
L LAST WARNING ISSUED
L - 30/00Z
F - 23/12Z
TCFA
ABPW
E 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 E
N 50 45 40 35 30 25 20 15 10 5 EQ

TYPHOON CAITLIN (09W)

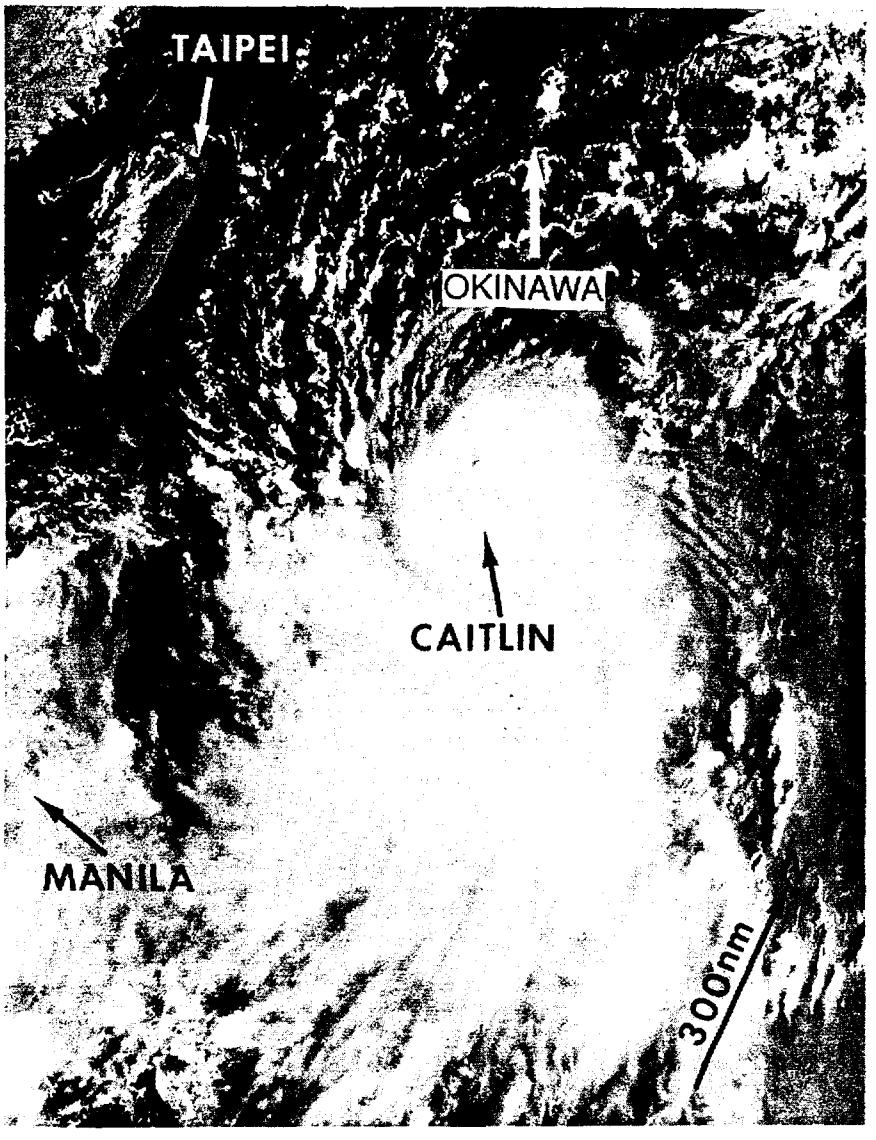

Figure 3-09-1. Caitlin has a cloud filled eye. To the north, the first line of enhanced cumulus cloud bands associated with the typhoon move across Okinawa (260028Z July DMSP visual imagery).

I. HIGHLIGHTS

After a succession of three straight-running July typhoons [Zeke (06W), Amy (07W), and Brendan(08W)], Caitlin became the first cyclone of the season to threaten Japan and Korea. Its north-oriented track was predicted by the NOGAPS model, and appeared to demonstrate the value of a newly implemented tropical cyclone bogus routine implemented at Fleet Numerical Oceanographic Center (FNOC). Much-needed rain fell on drought-stricken Okinawa as Caitlin passed west of the island.

II. TRACK AND INTENSITY

In mid-July, Caitlin developed from a disturbance in the eastern portion of the monsoon trough which extended south of Pohnpei in the eastern Caroline Islands. The disturbance moved west-northwestward, and was initially described on the 200600Z July Significant Tropical Weather Advisory as a low-level circulation with much of the deep convection displaced west of the center. On 22 July, upper-level wind shear diminished near the circulation center. Based on pressure falls of 1 to 2 mb per day at Yap (WMO 91413), and increased convective activity, a Tropical Cyclone Formation Alert was issued at 230500Z. The first warning on Tropical Depression 09W followed at 231200Z when a significant increase in convection indicated that continued intensification was likely to occur. Caitlin became a tropical storm at 240000Z.

Caitlin tracked west-northwestward until 24 July, when the subtropical ridge weakened near 130°E and allowed the tropical storm to make a sharp northward turn. For the next four days, it moved in a generally north-northwestward direction and slowly intensified. The development of an irregular, cloud-filled eye prompted an upgrade to typhoon intensity at 251200Z (Figure 3-09-1). At 271535Z, the center of the eye passed 60 nm (111 km) west of Kadena AB and Caitlin attained a peak intensity of

95 kt (49 m/sec) less than three hours later at 271800Z. After passing Okinawa, the typhoon tracked north-northeastward around the periphery of a broad mid-tropospheric subtropical ridge. On 29 July, Caitlin took a more northeastward track, accelerated through the Korea Strait, and gradually transitioned into a typhoon force extratropical low as it moved into the Sea of Japan. The final warning was issued at 300000Z when satellite imagery indicated the system had lost most of its tropical characteristics.

III. FORECAST PERFORMANCE

Initially, JTWC predicted Caitlin would follow a west-northwest track similar to the paths taken earlier by the three preceding typhoons. Of the suite of available computer forecast guidance, only the NOGAPS model indicated the cyclone would cease moving west-northwestward and assume instead a north-oriented track. This NOGAPS forecast was the subject of much speculation at the JTWC because it was uncertain if a recently implemented tropical cyclone bogus program was producing spurious output from the model. A post analysis evaluation of the bogus program, where bogus rawinsonde data derived from tropical cyclone characteristics are inserted into the NOGAPS model at the location of the tropical cyclone, showed that the program significantly improved model output in the tropics during 1991. After Caitlin made its abrupt northward turn on 24 July, JTWC forecasters responded by shifting the forecast from west-northwest to a northward track, which was consistent with the NOGAPS prognosis. As shown in Figure 3-09-2, official forecasts starting at 241800Z flip-flopped, or "windshield wiped" from northwest, to north, then north-northwest, before settling on a consistent northward track west of Okinawa. Forecast errors during this period were small,

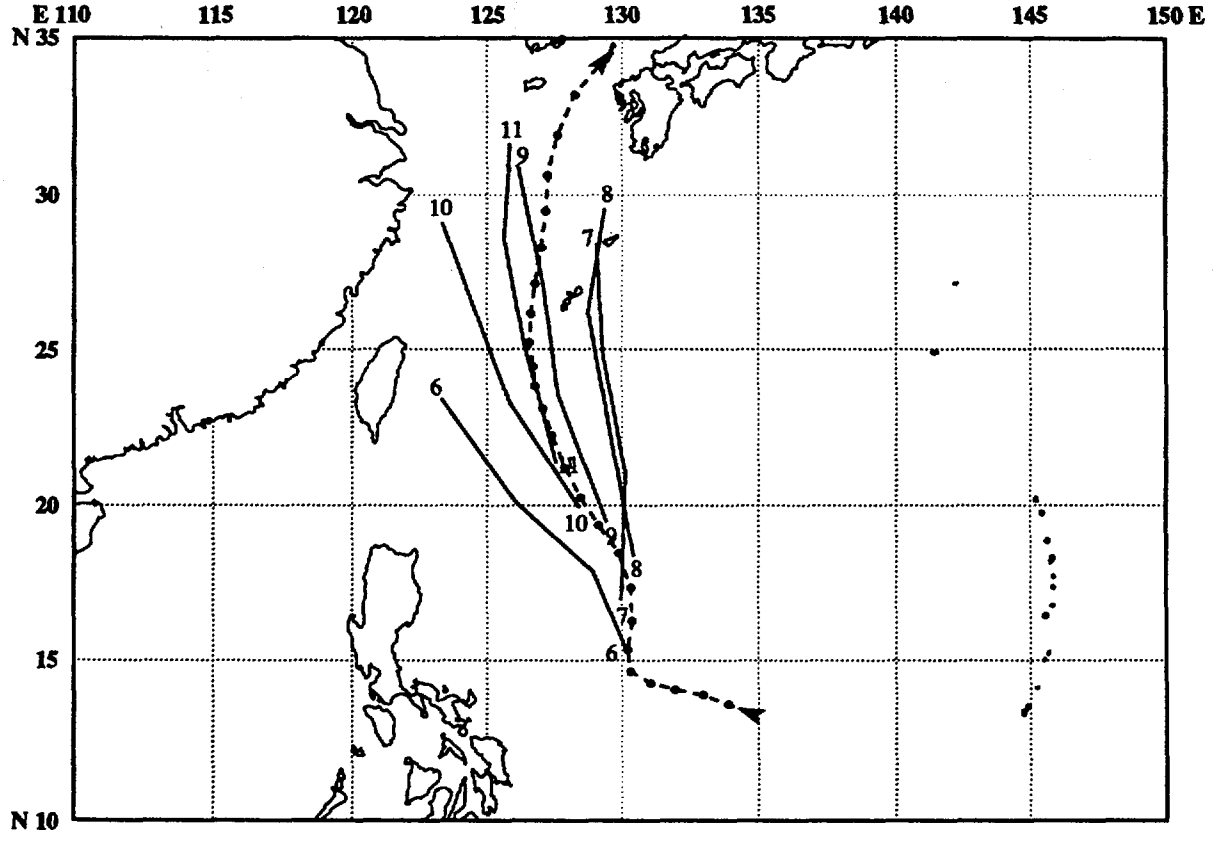

Figure 3-09-2. Comparison of JTWC forecasts issued from 241800Z to 260000Z July to the best track illustrates a significant change in JTWC track forecasts beginning at 250000Z (warning #7), and that a large degree of directional variability occurred in the subsequent track forecasts.

but the lack of continuity between successive warnings undermined confidence in the forecasts at a time when military units on Okinawa made the decision to evacuate. After shifting to its northward track forecast at 250000Z, JTWC forecast errors were exceptionally low, when compared with CLIPER and long term errors (Table 3-09-1). JTWC also outperformed OTCM at 24 and 48 hours.

IV. IMPACT

Caitlin provided welcome relief to the drought-stricken island of Okinawa. Kadena AB recorded a total of 12.51 inches (320 mm) of rain during a four day period, which was its heaviest precipitation since 1987. As a consequence, the reservoir level increased from only 35 percent to over 80 percent of its capacity. On Okinawa, one death was attributed to Caitlin, crop losses were estimated at $7.4 million, and U.S. military bases reported damage of more than $1.2 million. The typhoon enhanced the southwest monsoon across the northern Philippine Islands, and caused unwanted rainfall there. Manila received 8.38 inches (210 mm) of rain on 26 July, triggering avalanches of volcanic mud and debris, lahars, in the valleys near Mount Pinatubo and widespread flooding which resulted in 16 deaths and the evacuation of more than 20,000 people. Later, there were press reports of 2 deaths and over $4 million damage in Korea.

Table 3-09-1. Average 24-, 48-, and 72-hour forecast errors of the official forecast (JTWC) compared to CLIPER and OTCM for the time period 250000Z to 300000Z July, and the long term average JTWC errors.

	JTWC	CLIP	OTCM	Average
24 HR (17 cases)	70	81	91	120
48 HR (13 cases)	94	138	112	240
72 HR (09 cases)	146	266	126	360